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INSECTS INJURIOUS TO THE FRUIT OF THE APPLE

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NEARLY five hundred species of insects have been reported as feeding on the apple; however, a relatively small number of species are responsible for the heavy losses. In this lesson are discussed only the more important insects that attack the fruit itself: namely, codling moth, apple maggot, apple redbugs, fruit-tree leaf-roller, and green fruit-worms. The San José scale often stunts the fruit and disfigures it with red spots; but, as the more important injury is to the twigs and branches, this insect will be discussed in a future lesson. The plum curculio also causes the fruit to become knotty and deformed; it will be treated as a plum pest.

Owing to the stringent requirements of the apple packing law of 1914, fruit growers have been forced to take a greater interest in producing fruit free from all blemishes caused by insects. In order to produce clean fruit it is necessary that the fruit grower should be familiar with the various types of injury caused by the more important insect enemies of his crop, and that he should be acquainted with the more important facts in their life history. Most injurious insects have at least one vulnerable point in their life cycle when it is possible to do the most effective work in destroying them. Familiarity with the various stages of each pest is necessary in order to ascertain which are these weak spots and when they occur.

THE CODLING MOTH

Carpocapsa pomonella Linnæus

For nearly a century the codling moth has been the most serious insect enemy of the apple in New York. A native of Europe it was introduced into New England in the early part of the eighteenth century, whence

it gradually spread westward, reaching California about 1874. The losses caused by the codling moth are often severe; from one-fourth to one-half of the crop in the unprotected orchards of New York State is sometimes destroyed in this way. As a rule the percentage of infested apples is greater during years when there is a short crop than when the yield is large. The explanation of this is simple: when the crop is small there are more caterpillars in proportion to the number of apples. The estimated apple crop for New York State in 1914 was 6,500,000 barrels. Assuming that one-fourth of the crop was destroyed by the codling moth, the production of that year would have been 8,666,666 barrels. Thus the loss was 2,166,666 barrels, or $2,166,666, estimating these apples at $1 per barrel. According to the census of 1910 there were 11,248,203 bearing apple trees in New York State. It is estimated that 40 per cent of these trees are sprayed at least once for the codling moth. The cost of this work is not far from 10 cents per tree, or about $45,000. The sum of the loss of the fruit and the cost of spraying necessitated by the codling moth is at least $2,211,500, which represents the annual tax levied on New York State by this insect.

Owing to its great economic importance the codling moth has received more attention at the hands of entomologists than any other insect injurious to fruits, and the facts of its life history have been worked out with greater detail. Ranging throughout North America wherever the apple is grown, it has adapted itself to the variations in climate by modifying the length and number of generations produced annually. In New York State there are one brood and a partial second brood annually, but in the Lake Champlain district the second brood is so small as to be of little importance. The insect is, therefore, not so destructive in this State as it is farther south where the longer growing season permits more generations to develop.

Life history.— In New York the codling moth passes the winter as a full-grown caterpillar, curled up in a tough silken cocoon under flakes of bark or in crevices in the trees. While the greater number find suitable winter quarters on the trees, a few occasionally secrete themselves in piles of rubbish, in adjacent fences, or in other dry, protected places. Occasionally on young smooth-barked trees the caterpillars do not find a suitable hiding place on the trunk or branches, and they may then be forced to spin their cocoons under stones or in the space between the trunk and the soil; it is very doubtful if any of the caterpillars in these situations survive the winter. The cocoon measures from one-half to five-eighths inch in length and is composed of a thin tough layer of silken thread, in which is mixed bits of the bark or wood to which it is fastened. It is lined with white silk and the outside is rendered inconspicuous by the addition of bits of dirt and bark.

With the first warm days of spring the caterpillars begin to transform to dark brownish pupæ. The transformation usually takes place within the cocoon in which the caterpillar spent the winter, but in case the cocoon is in a deep crevice or under a tight flake of bark, the caterpillar may leave its winter quarters to construct a new cocoon nearer the surface; in the latter pupation takes place. Sometimes the caterpillar, without leaving the cocoon, merely opens the end and spins a silken tube out to the surface through which the moth is easily able to gain its freedom.

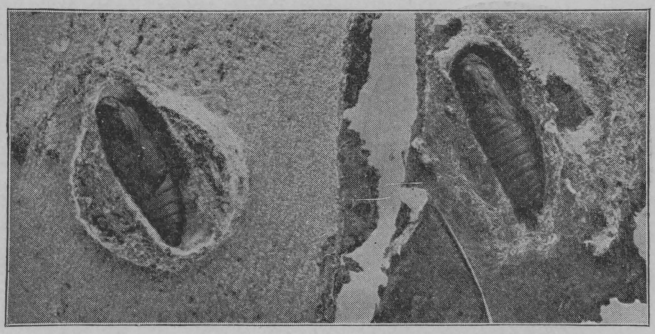

FIG. 93.— *Pupæ of codling moth, in their cocoons. Enlarged*

The pupa (Fig. 93) is about one-half inch in length; it is at first yellowish in color, but later it turns brown. The rate at which the caterpillars transform to pupæ depends considerably on the temperature, and pupation is greatly retarded by cold, backward weather. The average time spent in the pupa state is about four weeks for the spring brood.

The moths emerge during a period of several weeks, but the time at which the greater number appear varies considerably with the season; it is, however, usually about two weeks after the blossoms fall. The moths with wings expanded measure about three-fourths of an inch. The front wings have the general appearance of watered silk, which effect is produced by alternating irregular lines of brown and bluish gray. Near the hind angle is a large light brown area, bounded on the inner side by an irregular chocolate brown band, and crossed by two similar bands of a coppery or golden color in certain lights. The hind wings are coppery brown, darker towards the margin. The two sexes are very similar in appearance (Fig. 94).

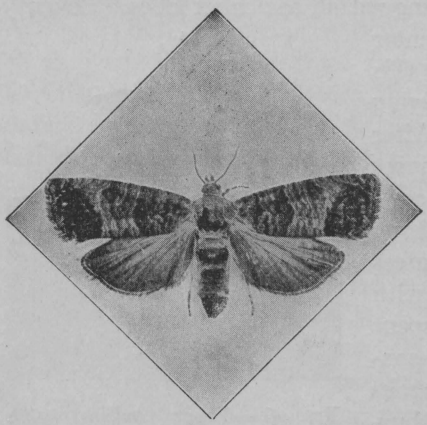

FIG. 94.— *Codling moth, enlarged*

If the weather is warm, egg laying begins in from three to five days after the moths have emerged; but if the weather is cold, it may be deferred for some time. The average life of the moth is about ten days, and each female lays from thirty to over one hundred eggs. The glistening, flat, oval, scalelike eggs are about half the size of a pinhead in diameter (Fig. 95). Those of the spring generation are laid mostly on the leaves, though a few are sometimes placed on the fruit and branches. Though the eggs are deposited throughout a period of several weeks, the greatest number are laid about three weeks after the blossoms fall. The eggs of the spring brood hatch in from six to ten days. In general in New York, though the condition of the weather will alter this somewhat, the earliest laid eggs will begin to hatch about three weeks after the petals fall, and hatching will be at its height about a week later, or about four weeks after the petals fall. This point is important from the standpoint of control and should be borne well in mind.

FIG. 95.— *Codling moth egg, greatly enlarged*

The newly hatched caterpillars are about one-sixteenth inch in length and semitransparent whitish in color with a blackish plate just behind the head and another at the hinder end, which are known respectively as the thoracic and anal shields. On the back are small blackish tubercles, which become less distinct with age. These little larvæ at first feed to a slight extent on the leaves, but most of them make their way directly to the young fruit where they begin feeding within the calyx lobes. Seventy per cent or more of the caterpillars enter the apples at the blossom end. It is this fact that is taken advantage of in spraying for the first brood of codling moth. After feeding for a short time in the calyx cavity (Fig. 96) the larva burrows to the core, eats the seeds, and hollows out a large cavity, which becomes filled with masses of excrement loosely webbed together with silk (Fig. 97). The length of time spent in the apple by each larva varies considerably, but averages about four weeks for the first brood. The larva then burrows to the surface and makes an exit hole, usually on the side of the apple, which it keeps plugged with frass (Fig. 98). When full grown the larva measures about three-fourths inch

FIG. 96.— *Young codling moth larva feeding in calyx cavity*

in length and is pinkish white in color with the head darker brown and the thoracic and anal shields lighter brown (Fig 99).

Most of the larvæ come out of the fruit before it falls, and crawl down the branches until they find a suitable place in which to spin cocoons. The caterpillars of the spring brood are divided into two classes: first, overwintering caterpillars, those that do not transform to pupæ until the following spring; second, transforming larvæ, those that transform during the same season producing another generation. The larvæ that winter over spin thicker, stronger cocoons than those that are destined to transform during the same season. The cocoons of the transforming larvæ are used only for a short time, are therefore more loosely woven, and are provided with an exit tube for the moth. In New York the transforming larvæ, as a rule, leave the fruit before August 1, but they comprise only a small percentage of the total number that spin cocoons before that date. The moths of the second brood begin to emerge about the first of August and continue until the early part of September. Within a few days these moths begin to lay eggs, which hatch in about ten days. A larger proportion of the eggs of the second brood are laid on the fruit than is the case with the first brood, and a larger proportion of the larvæ of the second brood enter the fruit at the side than did the first brood. These caterpillars remain in the fruit, on an average, between five and six weeks.

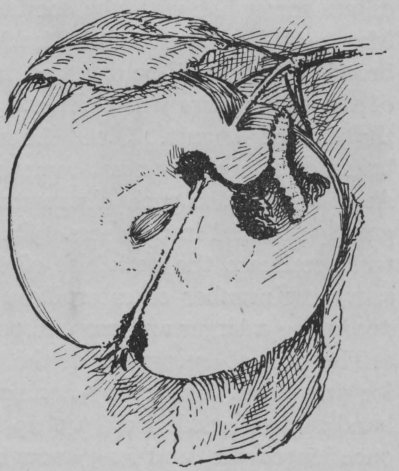

FIG. 97.— *Full-grown codling moth burrowing in an apple*

FIG. 98.— *Exit hole of codling moth larva, plugged with frass*

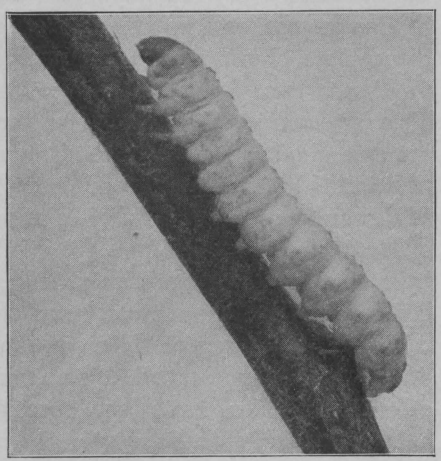

FIG. 99.— *Full-grown codling moth larva, enlarged about three times*

The second-brood moths begin to appear in New York during the latter part of July and the first of August, but the exact date of emergence differs somewhat with the condition of the weather and the locality. If May and June are cool and backward months, egg laying by the spring brood of moths will be retarded, and consequently a much smaller number of the caterpillars will complete their growth and leave the fruit before the first of August. Since the moths that lay the eggs for the summer brood of caterpillars must come from caterpillars that spin cocoons before August 1, under such circumstances this second, or summer, brood is greatly reduced in numbers. On the other hand, a warm May and June will accelerate the activities of the insects of the spring brood, so that a greater number of caterpillars will spin cocoons before August 1, thus producing a larger and more important summer brood.

The time of emergence of the second brood can easily be determined for any given locality by banding a few trees with burlap. A suitable band may be made from a strip from ten to fourteen inches wide, folded once lengthwise, and long enough to reach around the tree and have the ends lap. The ends of the band are held in place by a nail driven lightly into the tree where the ends meet. The bands should be in place by about the first of July in order to get the first caterpillars that leave the fruit. Some of the first-brood larvæ will take shelter under these bands and spin cocoons there. From about the middle of July on, these bands should be examined every few days; and when empty cocoons are found, it is an indication that the moths have begun to emerge, and that the young caterpillars of the second, or summer, brood will be entering the apples in about two weeks, depending, however, somewhat on the weather. This is the only sure method of determining when the second-brood moths are emerging, for the two broods overlap somewhat at times, and thus the first individuals of the second brood are often on the wing before the last of the first-brood moths have disappeared.

Natural enemies.— The eggs of the codling moth are often destroyed by a tiny wasplike parasite that deposits its eggs within the egg of the codling moth. The minute larvæ that hatch from these eggs devour the contents of the egg of the host, transform to pupæ within the eggshell, and finally emerge as adult parasites through a hole in the shell. Four of these parasites have been reared from a single egg. Other parasites attack the larvæ and pupæ of the codling moth, and it is subject in all stages to the ravages of predaceous insect enemies. In addition to the parasitic and predaceous insect enemies that attack the codling moth in its various stages, birds are efficient agents in holding the pest in check. Over a dozen species feed on it. The downy woodpecker, the nuthatch, and the chickadee destroy great numbers of the larvæ that winter under bark

flakes. Small flocks of these birds may be seen in the orchard during the fall and winter months carefully going over the trunk and branches of the trees searching for insect food. In Figure 100 *a* is shown an empty codling moth cocoon on the inner surface of a bark flake, and in *b* is shown the outer surface of the flake with a hole made by a woodpecker in extracting the larva. Many such flakes of bark may be found on apple trees infested by the codling moth. These birds are such efficient aids in destroying the codling moth that it will pay the orchardist not only to protect them but also in many cases to attract them to the trees by tying strips of beef fat or suet to a few branches. Birds will visit beef fat daily, and then spend hours in searching for insect food on the trees.

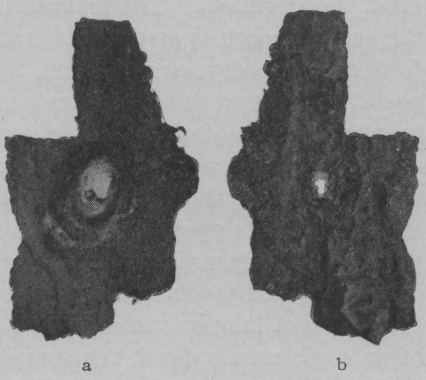

FIG. 100.— *Bark flake showing hole through which codling moth larva has been extracted by woodpecker: a, inner surface; b, outer surface*

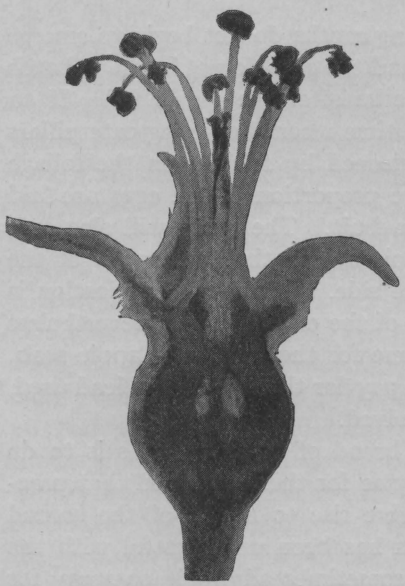

FIG. 101.— *Section through newly set apple showing calyx cavity, enlarged*

Means of control.—As has already been stated, seventy per cent or more of the first-brood larvæ enter the fruit at the blossom end. On this important habit of the codling moth rests the present system of controlling it with poison sprays. When the petals fall from the blossoms, the calyx lobes are spread apart enclosing a cavity, the bottom of which is formed by the bases of the stamens standing close together on the inner surface of the calyx cup, as shown in Figure 101. In the control of the codling moth an arsenical poison is sprayed into this calyx cup. In a week or so after the petals fall, the calyx lobes close over the cavity and prevent the poison from being washed out by the rain. On entering the apple the young caterpillar feeds for some time in the calyx cup, and is thus killed by the poison before the fruit is injured. The poison is applied just as the last of the petals are falling, because at

this time it can be sprayed into the calyx cup most easily. This is the most important spray for the codling moth and should be applied with great thoroughness. The material now almost always employed against the codling moth is arsenate of lead. It may be used either in the paste form or in the dry, or powdered, form. From four to six pounds of the paste or from two to three pounds of the powder should be mixed with one hundred gallons of water. It is necessary that the spray be applied with a pump giving a pressure of from one hundred to two hundred pounds per square inch, and the spray should be directed downward so as to hit the young fruits squarely in the blossom end. In order to do satisfactory work on the higher branches, the man handling the nozzle should stand on an elevated tower high enough so that with an extension rod twelve or fourteen feet long he can reach out over the top of the tree and by means of an angle nozzle direct the spray downward into the ends of the young apples. In the case of very tall trees it is impossible to thoroughly spray the tops; and under such circumstances it is better to head in the trees by judicious pruning. By doing very thorough work with this first spray it is possible to produce a crop of apples from ninety-five to ninety-eight per cent free from codling moth injury without making any later applications of the poison.

As has already been stated, the codling moths do not begin to emerge until about a week after the petals fall, and the eggs do not begin to hatch until about two weeks later, or three weeks after the petals fall. If an additional poison spray is applied at the time when the young caterpillars are hatching, many of them will be poisoned by feeding on the foliage before reaching the apples, since a large proportion of the eggs are laid on the leaves at some distance from the fruit. The spray will also coat the surface of the young fruits with poison, and thus kill many of the caterpillars that attempt to enter at the side. While this application is not absolutely necessary for the control of the codling moth, nevertheless a spray is usually applied about this time for the control of apple scab, and it will do enough good to more than pay for the arsenate of lead used, which is the only additional expense involved.

The best way to control the second brood of codling moths is to do such thorough and careful work in spraying for the first brood that practically no caterpillars will survive to give rise to moths of the second generation. In case, however, a person has been unsuccessful with the earlier applications of the poison, it is sometimes advisable to spray for the second brood about the first of August. As has been stated, the size and the importance of this second brood depend on the earliness of the first brood, and this in turn depends on the temperature during May and June. When the season has been early, there is more danger that the

crop will suffer from the attacks of second-brood larvæ, and under such circumstances, the late spray is more important than in years when growth has been more backward in the early part of the season. Here again, it is often desirable that poison be applied in combination with a fungicide in order to prevent late infections of apple scab.

Spraying schedule for the codling moth

A. *When the last of the petals are falling*

Arsenate of lead, 4 to 6 pounds in 100 gallons of lime-sulfur (32° Baumé) diluted 1 to 40. This is the most important spray for the control of codling moth and should never be omitted.

B. *About three weeks after the petals have fallen*

Arsenate of lead, 4 to 6 pounds in 100 gallons of lime-sulfur (32° Baumé) diluted 1 to 40.

C. *About August 1*

Arsenate of lead, 4 to 6 pounds in 100 gallons of lime-sulfur (32° Baumé) diluted 1 to 40.

THE APPLE MAGGOT

Rhagoletis pomonella Walsh

Summer and early fall apples in New York State are often badly infested by small whitish maggots (Fig. 102) about one-fourth inch in length, which tunnel through the fruit in all directions. Although summer and early fall varieties are most susceptible, winter apples are often seriously injured. Subacid and sweet varieties are most liable to infestation, but acid varieties, such as Baldwin, Rhode Island Greening, and Oldenburg, and even crab apples are sometimes attacked. Fameuse is very susceptible to injury by the apple maggot in the Lake Champlain district.

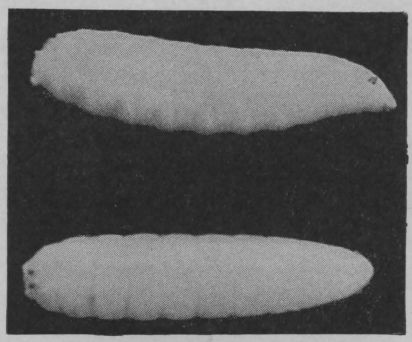

FIG. 102.— *Lateral and dorsal view of full-grown apple maggots. Enlarged*

Life history.— The parents of this maggot are two-winged blackish flies somewhat smaller than the house fly, with yellowish head and legs and three or four transverse whitish bands on the abdomen. The wings are marked with four confluent brownish bands (Fig. 103). In New York these flies first appear in the orchard in early July, usually from about the fourth to the middle of the month, and are common until the latter

part of September. The flies feed for from one to three weeks before egg laying begins. During this time they may be observed lapping drops of moisture from the fruit. The manner in which they take their food is interesting and also important from the standpoint of control. The mouthparts of these fruit flies are fitted for lapping or licking rather than for sucking or biting. The proboscis (Fig. 104) is a tonguelike organ roughened and somewhat enlarged on the end, by means of which fluid or semifluid substances may be lapped up.

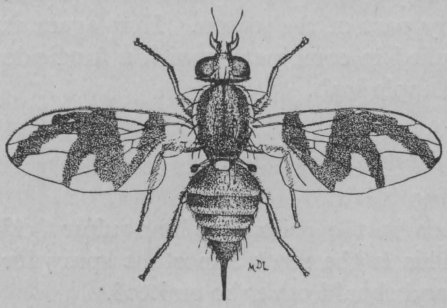

FIG. 103.— *Female apple maggot fly*

As has been stated, from one to three weeks of feeding must take place before the eggs are fully matured within the body of the female. At the end of this period egg laying begins. The female bears on the end of the abdomen a sharp ovipositor with which she inserts her minute, elongate, whitish eggs into the pulp of the fruit just beneath the skin (Fig. 105). Each female is probably capable of laying between three hundred and four hundred eggs. The eggs hatch in from two to six days. Immediately on hatching, the little maggots begin to tunnel just beneath the skin or into the fruit, but they grow slowly until the fruit begins to ripen or to decay (Fig. 106). Badly infested fruit often shows large brown areas on the skin, where decay has set in due to the presence of the maggots. Sometimes the maggots tunnel just beneath the skin, and in the light-colored varieties these burrows show through as winding darker areas. From this habit the insect has received, in many localities, the name of railroad worm. In many cases the apples are apparently sound at picking time, but later when they begin to soften in storage or in shipment, the maggots develop and render them unfit for use.

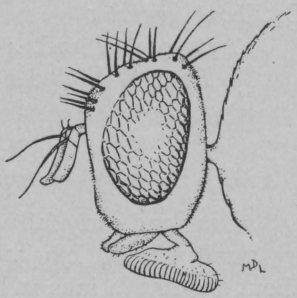

FIG. 104.— *Head of apple maggot fly showing lapping type of mouth parts*

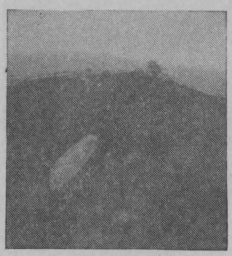

FIG. 105.—*Egg of apple maggot inserted in the flesh of an apple just beneath the skin. Greatly enlarged*

The length of time that the maggots spend in the apples varies considerably with the condition of the fruit and of the

weather. If the fruit is ripening and if the weather is warm, the larvæ may become fully developed within two weeks after hatching from the eggs; while on the other hand if the fruit is hard and green and if the weather

FIG. 106.— *Apples infested by apple maggots, cut open in order to show decaying interior*

is cold, the maggots do not mature so quickly, and the time of emergence from the apples may be deferred for months. A case is on record where in January maggots were observed leaving the apples in storage. The presence of maggots in the fruit usually hastens decay and causes the apples to drop to the ground. When the larva becomes full-grown, it leaves the fruit by a small ragged exit-hole in the skin, burrows an inch or so into the ground, and its skin contracts and hardens to form a tough leathery protective covering known as a puparium (Fig. 107), which somewhat resembles a grain of wheat. Within this puparium a series of remarkable changes takes place, in which the organs of the larva are broken down and made over into those of the adult, or fly. By the end of the second day the true pupa is formed within this protective covering, and the head, legs, and wings of the fly become apparent. In this stage the insect spends the winter, and the following spring the fly emerges through a circular split at the head end of the puparium. In New York, however, during the

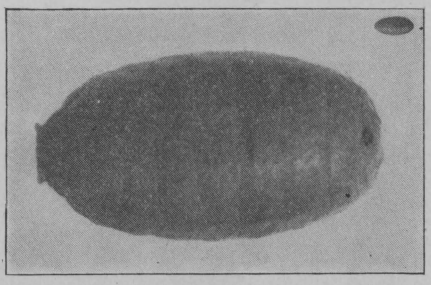

FIG. 107.— *Puparium of apple maggot, enlarged. Natural size shown in upper right-hand corner*

latter part of September a few of the puparia transform to flies and thus produce a partial second brood. This brood is small and probably does but little damage.

Means of control.— Injury by the apple maggot is most severe in neglected, unpruned, uncultivated, and unsprayed orchards. As a rule it is rarely troublesome in orchards that are properly cultivated and that have regularly received the usual sprays made for the codling moth. In orchards which for the past few years have been seriously infested it would be advisable to make three or four applications of sweetened arsenate of lead at intervals of a week, beginning when the flies first appear on the trees. The sweetened spray is prepared according to the following formula:

Arsenate of lead	6 pounds
Cheap molasses	2 gallons
Water	100 gallons

The sweetened spray need not be applied with the care used in ordinary arsenical spraying, because it is in the nature of a bait to which the flies are attracted and on which they feed and die.

THE APPLE REDBUGS

Heterocordylus malinus Reuter and *Lygidea mendax* Reuter

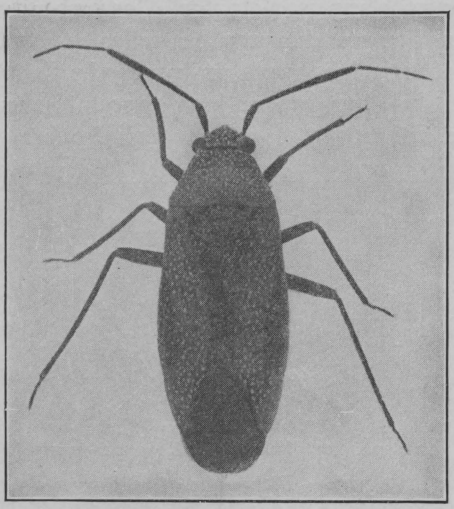

FIG. 108.— *Adult apple redbug, enlarged*

Although apple redbugs had been under observation for some years at Ithaca, the first serious outbreak in New York State was in the spring of 1908 in a large orchard near Syracuse. Since that time they have been increasing in importance as an apple pest until they are now fairly common through the apple-growing regions of New York except in the northern part of the State.

There are two kinds of apple redbugs that are closely related and resemble each other in general appearance. For convenience in referring to them, one has been called the apple redbug and the other the false apple redbug. The adult apple redbug is about one-fourth inch in length (Fig. 108) and varies in color from red to black, and the

whole upper surface of the body is thinly covered with conspicuous white, flattened, scalelike hairs. The adult of the false redbug (Fig. 109) is of almost the same size as the preceding, but the color is generally a lighter red, and there are no white hairs on the upper surface of the body.

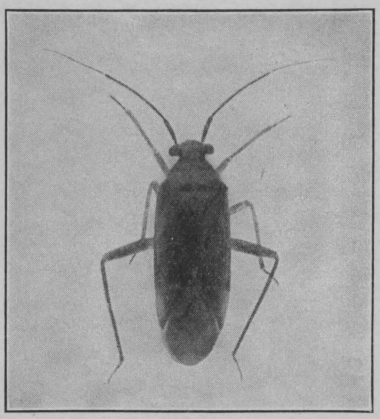

FIG. 109.— *Adult false apple redbug, enlarged*

Life history.—The life histories of these two redbugs are similar. The insects spend the winter in the egg stage. The eggs are dull whitish, sharply curved, and slightly compressed. These are inserted by the females, during late June or early July, their full length into the bark of the smaller branches, preferably of the previous season's growth. As far as is known, the eggs of the redbug are placed in a slit in the bark at the base of the fruit spurs and around the buds, while those of the false redbug are usually inserted in the lenticels of the smooth two-year-old wood (Fig. 110). The eggs of the redbug hatch after the fruit buds burst, and hatching is about over by the time the blossoms open. Those of the false redbug hatch about a week later, or while the trees are in blossom.

FIG. 110.— *Section of twig showing egg of false apple redbug*

The young nymphs of the two species are very similar in appearance. Those of the false redbug (Fig. 111) may be distinguished by their brighter red color, the absence of darker markings on the thorax, and by the body's being covered with fine short black hairs. This species retains its bright color until full-grown, but the redbug (Fig. 112) becomes nearly black on the thorax after the third molt.

The redbugs pass through five immature, or nymphal, stages, the wing pads becoming more apparent each time the skin is shed until

with the fifth molt the wings are fully developed. The insects reach maturity in about a month after hatching.

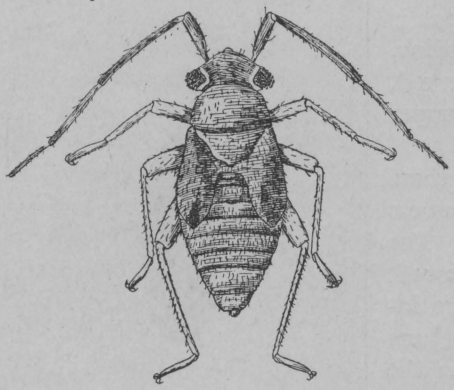

FIG. 111.— *Fifth stage nymph of false apple redbug*

Shortly after hatching the young nymphs make their way to the leaves from which they suck the juices by means of the slender bristles within their beaks. The leaves become spotted with minute reddish dots due to the small feeding-punctures of the nymphs. This condition is often the first indication of the presence of redbugs, since the insects themselves are very shy and extremely difficult to locate among the opening buds in an orchard. The nymphs may live on the foliage until full-grown, but usually they attack the fruit as soon as it sets (Fig. 113). The injury to the foliage though often conspicuous is of little importance, and it is to the fruit that the greatest damage is done. When the fruit is very young the bristles of the young bug's beak may penetrate to the center. The tissue about this puncture becomes discolored (Fig. 114) and hardens so that a corky thread extends to the core. Many of the injured apples fall to the ground, others dry up on the trees, while the remaining ones mature but are knotty and unmarketable.

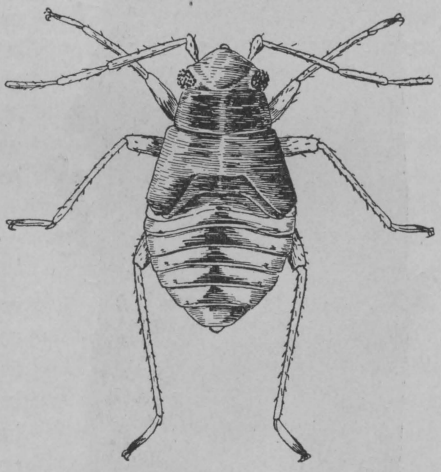

FIG. 112.— *Fifth stage nymph of apple redbug*

Apparently Rhode Island Greening, Pumpkin Sweet (Pound Sweet), Ben Davis, and Northern Spy, in the order named, are the most susceptible to injury, but other varieties are also somewhat liable to attack. Occasionally the entire crop may be rendered worthless for market, but ordinarily the extent of the injury is much less. It sometimes happens that about twenty-five per cent of the crop is rendered unmarketable. Knotty apples are also caused by curculio punctures and by aphis injury. Redbug injury may be distinguished from that of the plum curculio by

the fact that no tissue is removed, the juice merely being sucked out, causing a smooth depression in the fruit (Fig. 115). The feeding and egg-laying punctures of the curculio cause characteristic scars, as shown in Figure 116. Aphis injury is characterized by a puckering about the blow end of the fruit, which does not appear in typical redbug injury.

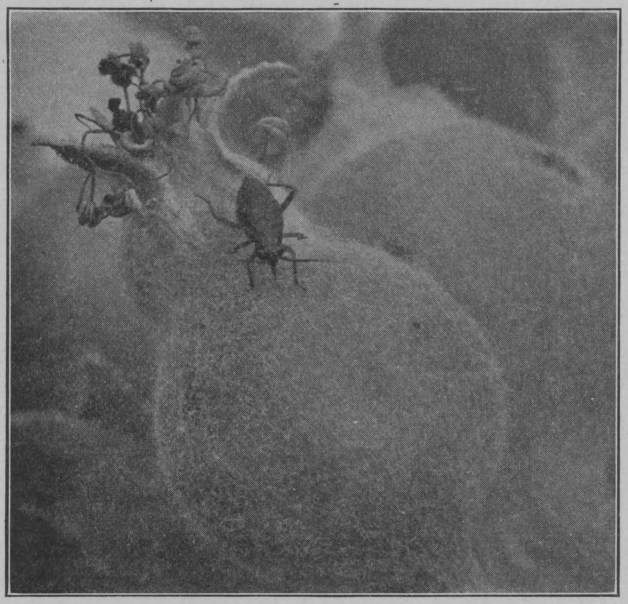

FIG. 113.— *Nymph of apple redbug feeding on a young apple*

Means of control. — If only the true redbug of the apple is present in the orchard, it can be effectually controlled by a thorough application of "black leaf 40" tobacco extract. It should be mixed in the proportion of 1 pint to 100 gallons of water, and 4 or 5 pounds of soap should be added to the mixture in order to make it stick and spread better. This spray should be applied about the time the blossoms show pink, in order to kill the nymphs while they are still young. If, however, as is usually the case, the false redbug is also present, the application should be repeated just after the blossoms fall in order to kill the young of this species.

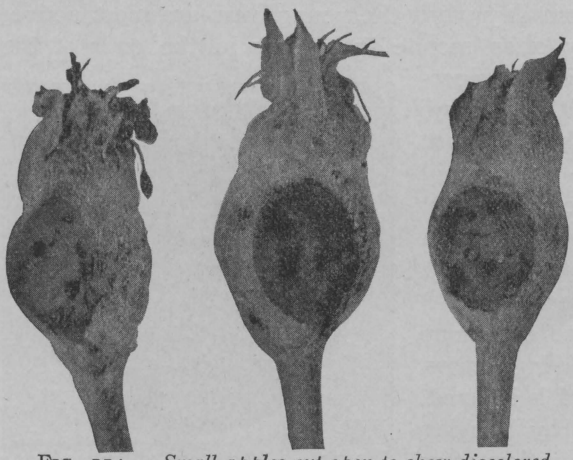

FIG. 114.— *Small apples cut open to show discolored areas around the punctures made by redbugs*

The two applications coincide with the first scab spray and the calyx

spray for the codling moth. "Black leaf 40" can be satisfactorily combined with the dilute lime-sulphur and arsenate of lead used at these times. In this case the soap cannot be added. These applications should be sufficient to control an ordinary infestation of redbugs. In case, however, the insects are present in great numbers, it is necessary to use such large quantities of the spray liquid that there is danger of foliage injury from the lime-sulfur. Under such circumstances the "black leaf 40" spray should be applied separately. It is necessary to spray for redbugs at the times indicated, because a little later, when the redbugs have become larger, they are very resistant to the sprays, and it is then much more difficult to kill them. If the spraying is done too early some of the eggs will not have hatched.

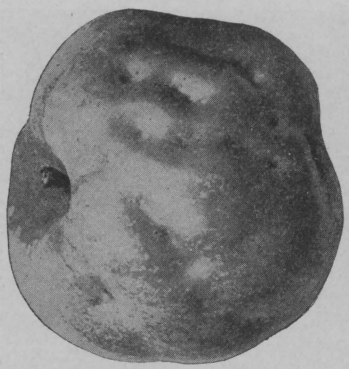

FIG. 115.—*Mature apple, showing injury by redbugs*

In order to spray successfully for redbugs very thorough work must be done. The insects have mouth parts of the sucking type, and it is therefore necessary to hit every insect with the spray so as to wet it thoroughly. Moreover, the young nymphs are extremely agile and readily dodge to the other side of a branch or take refuge among partly expanded clusters of leaves. In order to be most effective the spraying should be done on a warm day when the young bugs are most active, for in cool weather they often secrete themselves in the curls of the unopened leaves where it is impossible to reach them with a spray. A fairly coarse nozzle with a moderate pressure, from 100 to 120 pounds, will be found the most satisfactory. When the nicotine solution is combined with lime-sulfur and arsenate of lead, a finer nozzle should be used.

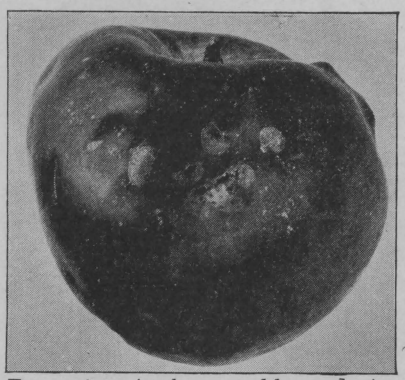

FIG. 116.—*Apple scarred by egg-laying punctures of the plum curculio*

It is often desirable to determine in advance of the spraying season whether or not an orchard is infested. This may be easily done by bringing small branches indoors any time after the first of March and by placing them in dishes of water to force out the buds. If eggs are present on these branches, the young redbugs will appear at the proper time and

will begin feeding on the leaves and the blossoms, and in this way a person is easily able to determine which species is present.

THE FRUIT-TREE LEAF-ROLLER

Archips argyrospila Walker

For some years past, in Colorado and Missouri orchards this leaf roller has been one of the most serious insect pests with which apple growers have had to contend. It has been found in New York State since 1874, and in 1888 and 1892 it was recorded as injuring apples and pears to a slight extent, but it was not until 1911 that it suddenly became a serious apple pest. During the spring of that year the insects appeared in very large numbers in an orchard in Genesee County and in varying numbers in many other orchards in the State. Since then it has been increasing in importance as an apple pest, until during the past season it caused more or less injury in most orchards throughout the apple-growing sections and was very injurious in certain widely separated orchards in western New York.

FIG. 117.— *Egg mass of fruit-tree leaf-roller, showing holes through which the young caterpillars emerged. Enlarged*

The fruit-tree leaf-roller, though an apple pest, by no means confines its attacks to this fruit. It is also very destructive to pears and has been found feeding in this State on sweet cherry, wild cherry, plum, quince, black walnut, and mountain ash. In the West it has been observed on rose, currant, gooseberry, apricot, Osage orange, box elder, sassafras, and hazel, in addition to its more common orchard food plants. It has also been collected from a number of different kinds of shade and forest trees.

Although this insect is not equally injurious from year to year in any given locality, on account of its wide range of food plants it is easily able to maintain itself in a section until such time as conditions are favorable to its rapid increase. It may then suddenly become one of the most serious pests with which the apple grower has to deal.

Life history.— This insect spends the winter in the egg stage. The eggs are laid on the smaller twigs and fruit spurs in small oval, flat, grayish patches, about one-fourth inch in diameter (Fig. 117). The average number of eggs in one of these masses is about one hundred and fifty though this often varies considerably. Each egg mass is protected by a smooth varnish-like substance. In New York State the eggs hatch just as the buds are bursting, and by the time the blossoms show pink

hatching is practically complete. The young caterpillars are about one-twenty-fifth inch in length and of a light green color with a black head and a black thoracic plate just behind the head. They bore into the opening buds and feed on the expanding leaves, which they web together to form a loose nest. As soon as the blossoms fall, the partly grown caterpillars attack the fruit, first devouring the calyx lobes and then eating large irregular holes in the young apples. It is to the fruit that the chief injury is done, though frequently many buds and much of the foliage are destroyed, and in a number of cases large orchards have been completely defoliated by this insect. The most severely injured apples soon drop from the tree; those which are not so badly eaten mature but are knotty. The wounds made by the caterpillars heal over, leaving large, brownish, corky scars, which render the apples misshapen and unmarketable (Fig. 118). The scars caused by the leaf roller are, as a rule, deeper than those made by the green fruit-worm.

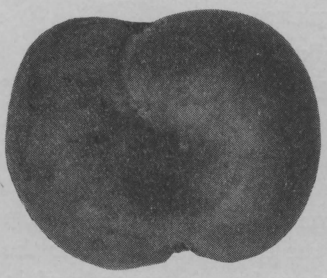

FIG. 118.— *Mature apple, showing scar of wound made by fruit-tree leaf-roller when the fruit was small*

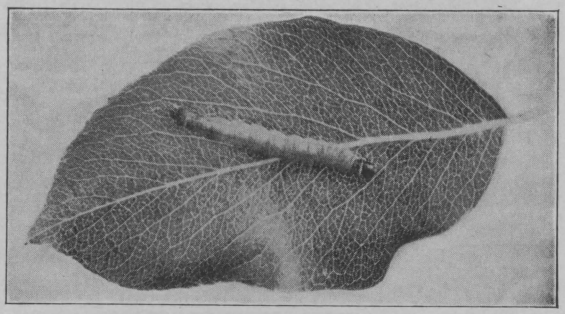

FIG. 119.— *Full-grown leaf-roller caterpillar*

The caterpillars become full-grown in about three weeks, at which time they measure about one inch in length and are of a light green color with head, legs, and thoracic shield varying from brown to black (Fig. 119.) They then transform to brown pupæ (Fig. 120) within a rolled leaf (Fig. 121) and in about ten days, or early in June, the moths emerge. These insects have a wing expanse of from three-fourths of an inch to one inch. The front wings are mottled with various shades of rich brown and yellowish white. Some are much darker than others, and the distinctness of the markings varies considerably (Fig. 122).

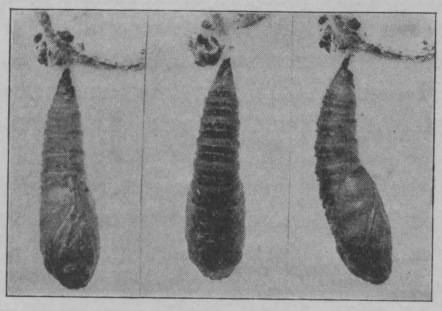

FIG. 120.— *Pupæ of fruit-tree leaf-roller*

The female moth lays her eggs in flat masses usually on the twigs and smaller branches. In New York most of the eggs are laid by the last of June, but they do not hatch until the following spring. There is only one brood annually, about ten months being spent in the egg stage.

FIG. 121.— *Leaf rolled by fruit-tree leaf-roller*

Means of control.— The fruit-tree leaf-roller has been found to be a difficult insect to control. It often happens that its most destructive outbreaks occur in well-sprayed, well-cared-for orchards. This is because the eggs are not injured by the lime-sulfur spray usually applied, and because the caterpillars feed in the open only for a short time after the buds have burst, at which time no arsenical is ordinarily applied to the trees. Thus this insect is able to escape the applications usually given in a spraying schedule.

The method employed in controlling the leaf roller will depend entirely on the amount of infestation. This can be estimated by the amount of injury done to the crop of the preceding year or less readily by an examination of the trees for egg masses. In cases where only a moderate infestation is indicated, a reasonable degree of control can be obtained by thorough spraying with arsenate of lead, $2\frac{1}{2}$ to 3 pounds in 100 gallons of water. This should be applied as soon as the leaves of the cluster buds begin to open.

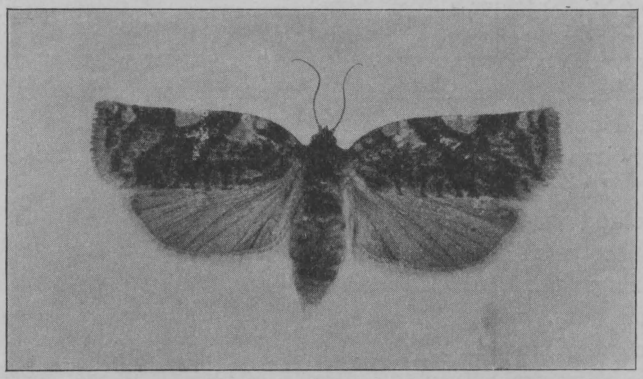

FIG. 122.— *Moth of fruit-tree leaf-roller*

In cases of severe infestation, experience has shown that the pest cannot be controlled by the use of arsenical sprays alone. In such cases

the trees should be sprayed just before the buds open with a miscible oil, 1 gallon in 15 gallons of water. Great care should be taken to do thorough work and to apply the liquid so as to wet each egg mass. In this way from seventy to ninety per cent of the eggs can be destroyed, but this treatment alone cannot be relied on to control the pest. It must be supplemented by one or two thorough applications of arsenate of lead, $2\frac{1}{2}$ to 3 pounds in 100 gallons of water, made just after the buds have opened. That is, the trees should be sprayed as soon as the buds burst and then resprayed immediately.

GREEN FRUIT-WORMS

Xylina antennata Walker, and other species

Although green fruit-worms are generally distributed throughout the State they do not often become of importance as apple pests. They are primarily forest insects feeding on the foliage of poplar, soft maple, hickory, and wild cherry. Serious outbreaks have occurred at long intervals, 1877, 1896, and again in 1913. For the past two years they have been especially troublesome in the orchards of Clinton County. The scarcity of these insects over long periods of time has been attributed to adverse climatic conditions and to the depredations of parasitic enemies. In years of abundance these caterpillars are capable of causing great losses to the apple crop, and growers should be familiar with the nature of the injury and should understand the best means of preventing such loss.

FIG. 123.—*Eggs of green fruit-worm on twig, enlarged*

Although there are three closely related species of green fruit-worms commonly destructive to apples, they are all very similar in appearance and habits. The parent moths appear in the orchard in March or April and deposit their small, nearly globular, ridged, yellowish eggs (Fig. 123) singly on the smaller branches or sometimes on the underside of the leaves. The moth has an expanse of about one and one-half inches. The fore wings are brownish gray with obscure darker markings; the hind wings are lighter in color (Fig. 124). The moths are sometimes a nuisance in sugar maple groves, where they are attracted to the sap and collect in great numbers in the sap pails.

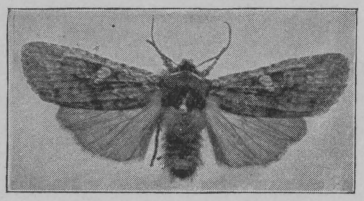

FIG. 124.— *Moth of green fruit-worm*

The eggs hatch as the buds are bursting, and the young caterpillars at first feed on the opening leaves. By the time the fruit sets most of

the caterpillars are half grown, and they soon turn their attention to the young apples. They begin feeding on the side of the apple and eat out large rather shallow cavities, often continuing their work until nearly half the fruit is devoured (Fig. 125). If the portion injured is not too large, the wound heals over, leaving a large, corky scar, and the apple matures. The scars made by the green fruit-worm are similar to those caused by the fruit-tree leaf-roller but, as a rule, are not so deep, although in many cases it is impossible to determine from the mature fruit which insect was responsible for the injury.

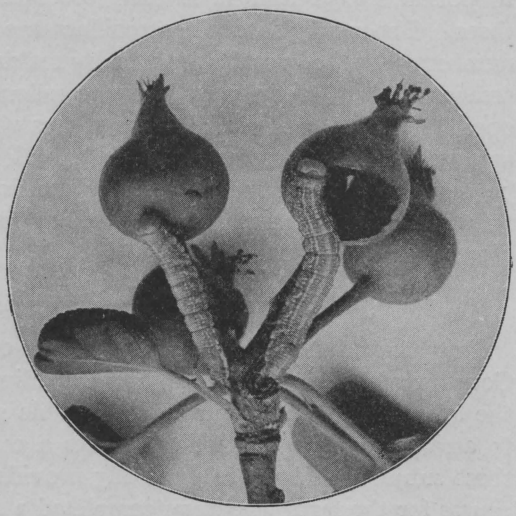

FIG. 125.— *Green fruit-worms feeding on young apples*

Green fruit-worms work on the fruit chiefly during May though some continue feeding until nearly the middle of June. When full-grown they range from an inch to an inch and a half in length and are light yellowish or apple green in color. A narrow cream-colored stripe extends down the middle of the back and a wide cream-colored stripe along each side with many similarly colored mottlings or spots, which sometimes form quite distinct stripes along the body above the broad lateral stripes.

FIG. 126.— *Pupa of green fruit-worm, enlarged*

By the first week in June most of the caterpillars have attained their full growth. They then burrow into the soil beneath the trees to a depth of from one to three inches where they roll and twist their bodies about until a smooth earthen cell is formed. Most of them then spin about themselves a thin silken cocoon; others spin no cocoon.

Soon after entering the ground the caterpillars transform within the cocoon or earthen cell to dark brown pupæ (Fig. 126). At the end of three months, or about the middle of September, most of the moths emerge and go into hibernation. Some of the pupæ, however, remain in the ground and do not transform into moths until the following spring.

Means of control.— When the caterpillars begin feeding on the fruit most of them are about half grown. At this time they are very resistant to poison sprays and it is then too late to do effective work against them. The newly hatched caterpillars are more easily poisoned. Their numbers may be greatly reduced by making one or two applications of arsenate of lead, 5 or 6 pounds in 100 gallons of water, before the blossoms open. In this case one of these sprays will coincide with the first scab spray when the blossoms show pink, and the arsenate of lead should be used in combination with the dilute lime-sulfur. In cases of severe infestation it is important that a poison spray be applied just before the blossom clusters separate.

ADVANCED READING-COURSES

Two advanced reading-courses are now offered by the Cornell Reading-Course for the Farm: the advanced reading-course in fruit growing and the advanced reading-course in vegetable gardening. These courses aim to assist persons who desire to make a careful and systematic study of these subjects. They are especially provided for members of the reading-course for the farm who have completed a study of the available reading-course lessons and who are now ready to specialize. A textbook, questions, and correspondence are used in conducting each course. Statements on important questions are prepared by the students, and are graded by an instructor and returned with helpful comments and suggestions. This provides an opportunity to have opinions and conclusions that are the result of study or experience, judged and corrected by an expert. The requirement of effort and thought on the part of the student by means of questions, and the returning of corrected papers with the grades, offer to the student some of the advantages of a correspondence course. The only expense connected with the courses is the purchase of the textbook. As this remains in the possession of the student, it may well be looked on as a permanent investment. The cost for the textbook in the advanced reading-course in fruit growing is $1.35, and in the advanced reading-course in vegetable gardening is $1.65.

The following is an outline of the nature and the requirements of the work given in the advanced reading-courses. The chapters in the textbook are studied consecutively, one at a time. The student's purpose should be to study, and not merely to read. Each chapter should receive considerable time and thought. The best results will be obtained by setting aside a definite time each day for the work. After making a careful study of each chapter, clear and concise answers should be made to the questions on it without referring to the text. In general it is expected that the course will be completed within six months. The student should

do the work regularly, covering at least one chapter every week, for by so doing interest in the course will not drag, and better results will be obtained.

Any resident of New York State who desires to enroll in either of the advanced reading-courses should write for further information to the Supervisor of the Reading-Course for the Farm, College of Agriculture, Ithaca, New York.

AVAILABLE READING-COURSE LESSONS FOR THE FARM, ARRANGED BY SERIES

Residents of New York State may register for one or more of the series mentioned below by addressing The Cornell Reading-Course for the Farm, College of Agriculture, Ithaca, New York.

SERIES	LESSONS	
The soil	74	Introduction to the principles of soil fertility
	42	Tilth and tillage of the soil
	50	Nature, effects, and maintenance of humus in the soil
	70	Soil moisture and crop production
	78	Land drainage and soil efficiency
Poultry	80	Incubation
	10	Feeding young chickens
Rural engineering	8	Knots, hitches, and splices
	*59	Sewage disposal for country homes
Farm forestry	12	The improvement of the woodlot
	28	Recent New York State Laws giving relief from taxation on lands used for forestry purposes
	40	County, town, and village forests
	62	Methods of determining the value of timber in the farm woodlot
The horse	46	Feeding and care of the horse
	56	Practical horse-breeding
Dairying	16	Practical dairy problems
	32	Composition of milk and some of its products
	54	The dairy herd
	60	Farm butter-making
	82	Cream separation
	86	The production of clean milk (in press)

*Lesson for the Farm Home.

SERIES		LESSONS
Fruit growing	22	The culture of the currant and the gooseberry
	36	Culture of red and black raspberries and of purple-cane varieties
	48	Culture of the cherry
	52	Culture of the blackberry
	72	Culture of the grape
Farm crops	20	Alfalfa for New York
	24	The rotation of farm crops
	66	Meadows in New York
Stock feeding	26	Computing rations for farm animals
Vegetable gardening	34	Home-garden planning
	58	Planting the home vegetable garden
Plant breeding	38	Principles and methods of plant-breeding
	44	Methods of breeding oats
	68	Improving the potato crop by selection
Country life	64	The rural school and the community
	76	Birds in their relation to agriculture in New York State
Insect	84	Insects injurious to the fruit of the apple

The above list is correct to April 15, 1915. The demand may at any time exhaust the supply of particular numbers. Requests will be filled as long as the supply lasts.